

TREATISE OF COMETS,

CONTAINING

- I. An Explication of all the various Appearances of the late COMET, both in its own Trajectory and the Firmament of Fixt Stars, to its setting in the Sun-beams : Illustrated with a Plan of the Earth's and Comet's Orbits.
- II. The History of Comets from the earliest Account of those kinds of Planets, to the present Time ; wherein the Sentiments of the Antient and Modern Philosophers are occasionally display'd. With Remarks on the Intentional End of Comets, and the Nature and Design of *Saturn's Ring*.
- III. The Distance, Velocity, Size, Solidity, and other Properties of those Bodies consider'd ; and the wonderful Phænomena of their Tails and Atmospheres accounted for. Illustrated also by a Copper-Plate.

By GEORGE SMITH.

Οἱ θεοὶ ἐκ νεφελῶν ἀναφαίνεσθαι ἔλπιον ἀστὴς
Παμφαίνων, τότε δ' αὖτις ἔδυν νέφεα σκίοεντα.

ὍΜΕΡ ΙΑ. Α.

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A
TREATISE
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COMETS, &c.

Of the various Appearances of the late COMET, both in its own Trajectory and the Firmament of Fixt Stars, till it set Heliacally in the Sun-Beams; with the natural and moral Consequences that might have attended its Course : To illustrate which is annex'd a Plan of the Earth's and Comet's Orb.



AT a Time when Astronomy has arriv'd to so great Perfection, thro' a laudable assiduity in its Promoters, I judg'd it might not be unacceptable to the Publick, to consider the Theory of Comets a little more attentively, by enquiring

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into their Astronomical, Historical and Natural Characters, thereby to fix their Doctrine, and discover the End for which they are design'd, which may serve as an Attempt left to the Improvement of succeeding Ages.

The remarkable Comet which lately made its Tour thro' our planetary Regions, shall serve as an Example for the rest, to conduct us through the first Part of my Design; and others will be introduc'd, as I perceive their necessity, to explain subsequent Phænomena.

On the 20th of *December* 1743, about Eight of the Night, there seem'd to be a new Star of the third or fourth Magnitude, near those of the Northermost *Piscium*, not suspected to be a Comet because it had no Tail. It was seen no more till *December* 27, when it equall'd those of the second Magnitude with a visible Tail, but extremely slow Motion, to what it had, being retrograde to the order of the Signs. Its appearance was in the uniform'd Space betwixt *Pegasus* and *Andromeda*, near the Stars of *Pisces*, tho' its Place was in *Aries*, the equinoctial Procession occasioning the Difference, with about 18° North Latitude from the Ecliptic. Hitherto its Motion was apparently slow; but as it proceeded nearly in the midway betwixt the *Lucida Capitis Andromedæ*, and that in the extremity of *Pegasus's* Wing, it began to accelerate its Motion. On the first of *February* it projected a long conspicuous Tail, thro' the Star in *Andromeda's* Head, almost to

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that in her Girdle, a Space of near 20° of the Firmament, but the most lucid Cone was not half the quantity. Inferenity of Air hinder'd any farther Observation till *February 11*, when it had passed *Marchab Pegasi* a considerable Way, and was proceeding fast in its Orbit towards its Peri-helion, with a long flaming Equipage of Tail. In order to ascertain its Place, I stretch'd a Thread thro' the *Lucida Pleiadum*, the Star in *Fronte Arietis* and the Comet's *Nucleus*: And again, thro' the *Lucida Capitis Andromeda*, that in *ejusdem Pedes* and the said *Nucleus*, but on account of the Comet's horizontal Depression, wou'd venture on no Computation from uncertain *data*.

On the 14th and 15th of *February* it was seen both Evening and Morning, moving very fast to appearance, and I judge, by its Velocity, towards the Sun, and the Comet's Retrogression, that it will accomplish its visible Course by the eighteenth, and set in the solar Beams; unless we may possibly expect to have the pleasure renew'd in its ascending Course, after it has undergone a burning Trial in the Regions of permanent Fire. Over what a wonderful extent of Firmament must then its flaming Tail project, when it spread so vastly long ere it reach'd the confines of the Sun?

Thus far in relation to its visible Course amongst the Fixt Stars; I come now to consider its real one, from thence to determine the true Causes of that seeming Irregularity,

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which I take to be chiefly Three: The first is owing to the Inequality of the Comet's Motion in its own proper Orbit, by which it did not pass over equal Spaces in equal Times, but, in Regions beyond the planetary System, had less of the solar Attraction, and a proportionable abatement of Velocity, till descending within our Orbits, and approaching its Peri-helion, the Motion was accordingly accelerated, and, by a plausible Conjecture, from the vast Excentricity of its Path, I am apt to believe that it will pass very near the Sun.

The other Cause of its anomalous Appearance, and by much the most considerable, was a concurring Position of the Comet's Orbit with the Earth's circular Motion in its proper Path; that Position being in the Plane of the Eye, and not in a lateral one, contributed principally to the visible Retardation of the Comet's Velocity, as will be made appear from the annex'd Scheme.

And as these two consider'd jointly, will solve every apparent Anomaly, there will be no occasion to embarrass the Plan with less important Affections, or to distract inferior Capacities by too strict a Disquisition into Astronomical Causes, which was not the Intent of this Treatise. I have only therefore exhibited the Figure of the Earth's annual Way, together with the Comet's Path and Place, to every tenth Day since its first Discovery,
till

till its final Exit, on a supposition of equal Velocities, and endeavour'd to render every thing as perspicuous as the nature of the Subject can possibly admit.

In the Scheme the little radiated Circle in the Center denotes the Sun, and the graduated ambient Circle with the Months, represents the Way of the Earth around it, whilst the Numbers distinguish the Place of the Earth to every ten Days, suitable to the Divisions on the Comet's Orbit, which is signify'd in the Draught by the long elliptical Path infolding the Sun at its lower Extremity, and widening as it extends upwards: The imperfect Arch where the Comet first appears and recedes, implies the Ecliptic, or the apparent Way of the Sun in the Firmament of Heaven, for the space of six Weeks, so much serving for our present Purpose. I have designedly omitted representing the Earth's Orbit elliptical, and left out the Paths of the other Planets, as unnecessary and to avoid Obscurity.

This premis'd, we have only to stretch a Thread from the Day of the Month in the Circle of the Earth's Course, thro' the correspondent Day in the Cometary Orb, and continue it in the same Direction to the Ecliptic, for the common Section of that Circle and Thread will exhibit the apparent Place of the Comet for that Day amongst the Fixt Stars.

Assume, for Example, the thirtieth of *December* in the circle of Months, and fixing
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one end of a Thread there, produce it in a strait Line thro' the Nucleus of the Comet, for the same Day on its Orb, quite to the Ecliptic, and note the Interfection; repeat the Operation for the tenth of *January* in the same manner, and mark that Interfection also, the difference between these two intersected Points shall represent the apparent Arch of the Comet's Motion, in the Expansum of the Fixt Stars for ten Days, which in this Example is very small, but was much less in the antecedent ten, as may be easily seen by repeating the Process.

But tho' this be the visible Motion accomplish'd by the Comet in ten Days, as beheld from the Earth, it has nevertheless moved over ten times that Space in its proper Orbit, and the Difference betwixt the real and apparent Motions is by no means equable, but subject to every imaginable degree of Variety in the process of the Course; for the Disparity of the two Motions is in their first Stage very considerable, and gradually approaches an Equality, when betwixt the tenth and the twentieth of *February* they become actually alike; and after the Comet has past its Perihelion, the apparent Motion exceeds the real, and greatly too, as they proceed; so that in three Days space the Comet will move over a visible Arch of the Firmament, equal to what is positively determined in its own Orb in ten. Afterwards, about *February 27*,
when

when a Tangent from the Earth touches the Comet's Way in Q, which is the Place of the Nucleus for the assign'd Day, the Comet will appear to have proceeded to the utmost limit of Retrogradation, with respect to the Signs, that Point of Reflexion I shall call the Comet's greatest Elongation, not disputing the Propriety, for I contend not about Terms.

When the Comet has arriv'd at its greatest Elongation, it will apparently traverse part of its former Course, and move *in consequentia*, or according to the Order of Signs, and yet not probably thro' the same Stars, because that will chiefly depend on the Position of the Comet's Orbit, together with its Inclination to ours. After the thirtieth of *March* it will appear to be Stationary with respect to the Fixt Stars, for almost ten Days together, and then seem to repeat a slow retrograde Motion, till it eludes the Sight in the interminable Regions of Immensity beyond the Solar System.

Hitherto we have explain'd the Appearances, arising from the compound Motions of the Earth and Comet jointly consider'd; a bare Inspection of the Scheme will convince you, that their real Motions have been permanently regular (secluding the first Cause of Anomaly, which I obviated before) whilst their seeming Motions have been strangely confounded. The Observation then of the *Cambridge* Gentlemen, bore the elegant Marks
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of Truth, when they discover'd that its Tail encreas'd in a visible Disproportion to its Progress *. Who, after this, can refuse to admit of the Earth's Motion, but an invincibly prepossess'd Enthusiast? especially when he duly contemplates, that not only the Planets, but even Comets themselves, are so sensibly affected by it; so that he must either allow the unaccountable Mechanism of a jumbled Universe, or grant the Hypothesis true; for my own Part I embrace it as Demonstration.

Notwithstanding that I have assign'd the Points of Station and Retrogression to certain Days in this Plan, yet I proceeded on no Astronomical Foundation to compute them; being principally solicitous of accomodating this Treatise to the Capacities of Gentlemen that have sufficient strength of Reason, to apprehend Things deliver'd in a familiar Way, and yet want Leisure or Groundwork to discuss the Analysis of more profound Calculation; being likewise perswaded that we shall have no more the pleasure of beholding so glorious a Phænomenon in its Ascent from the Sun, when the wonderful extent of its Tail wou'd have presented a noble and uncommon Appearance. The Reasons that induce me to think so are chiefly these:

First, The length of Days.

Secondly,

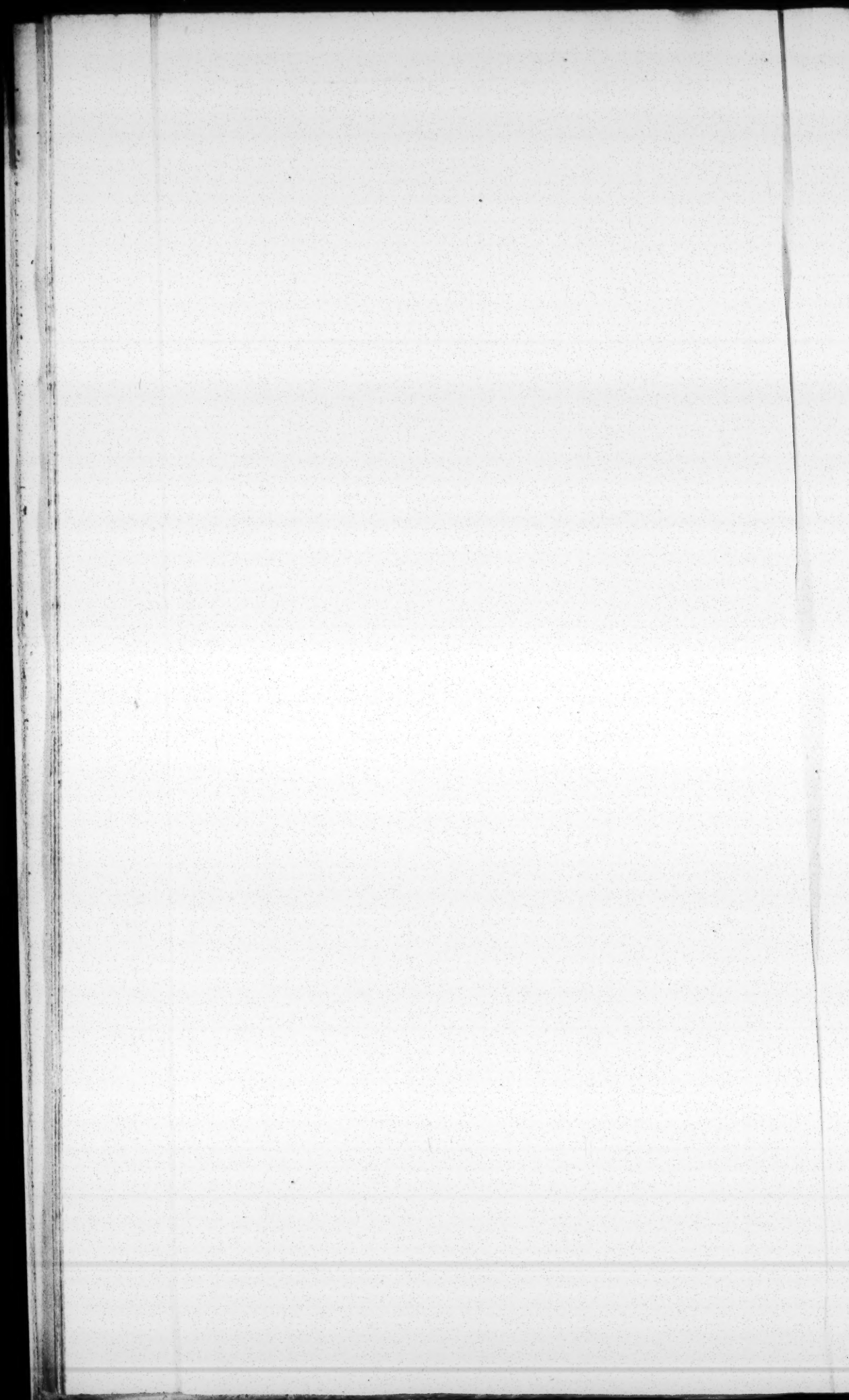
* See Supplement to the GENTLEMAN'S MAGAZINE for 1743. p. 702.

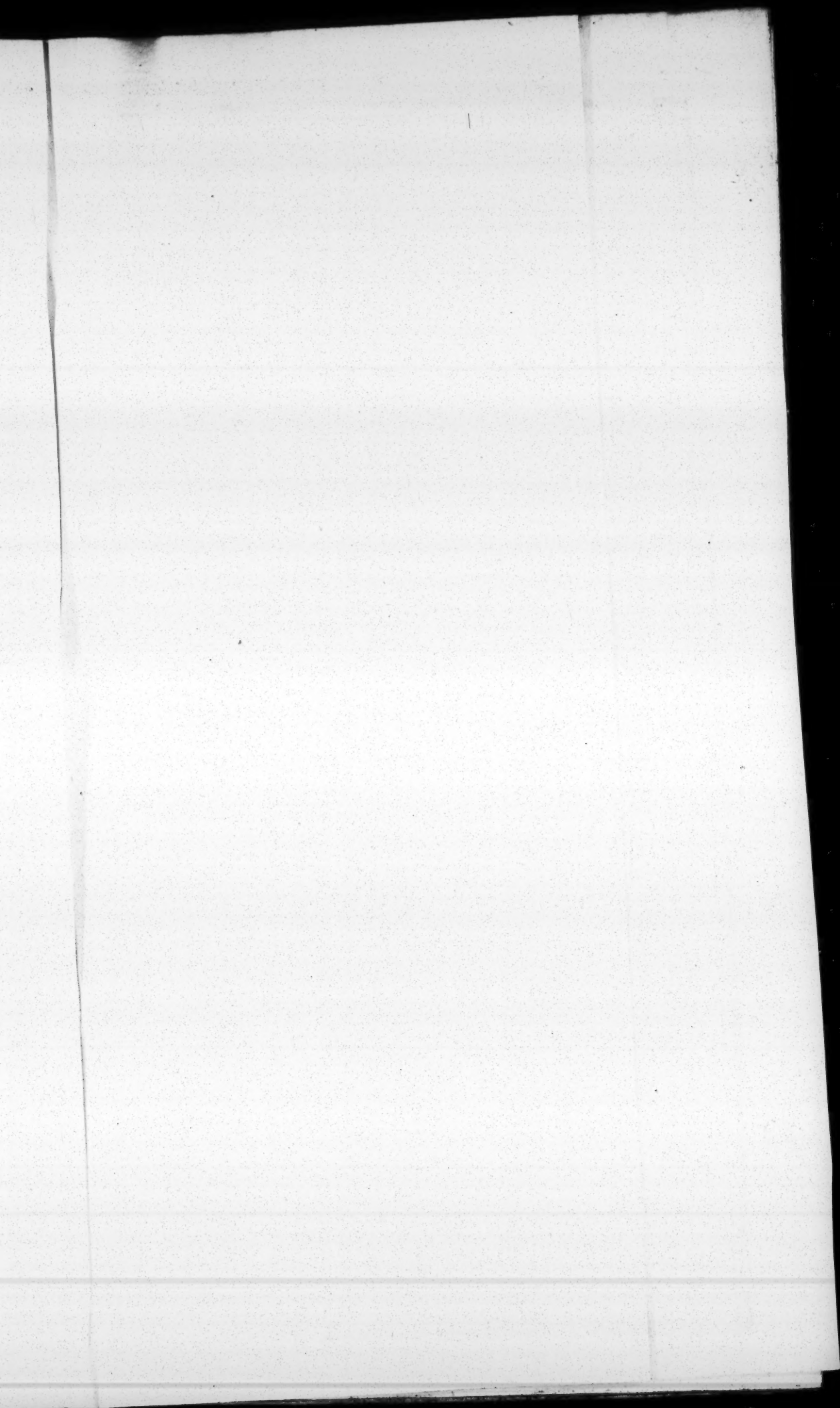
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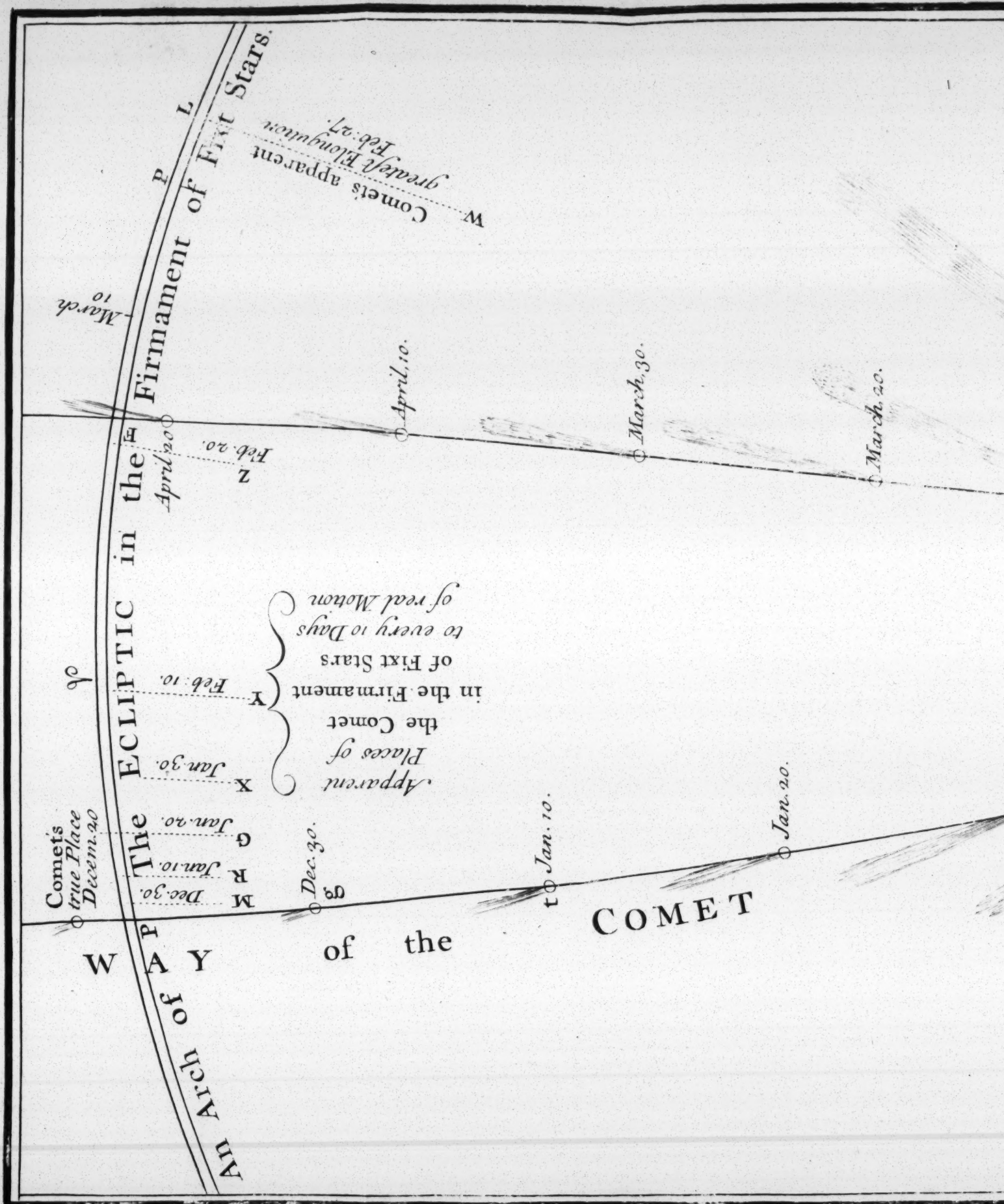
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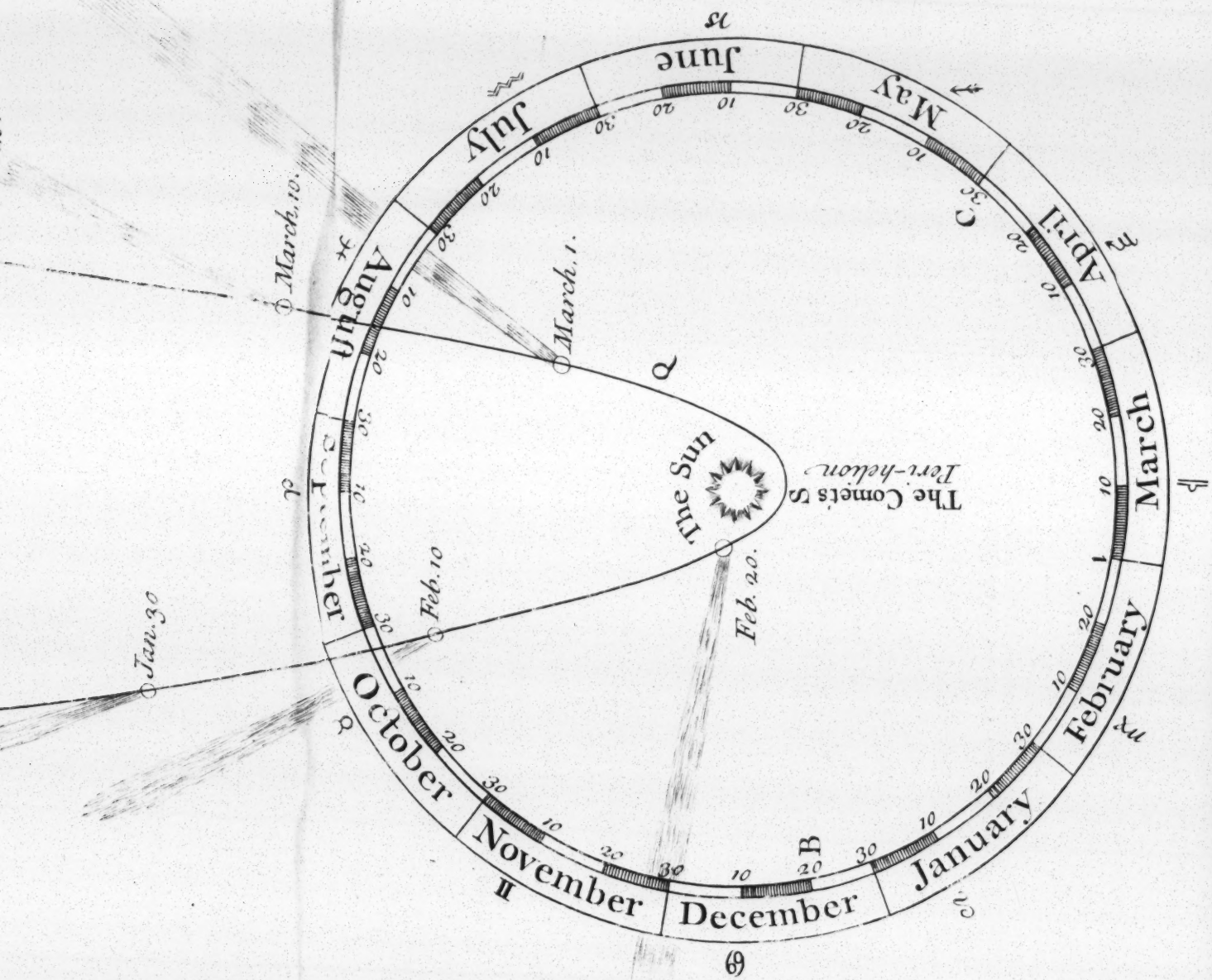
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Secondly, The Vicinity to the Sun on account of the vast Eccentricity of the Orbit which limits its Progress to the inferior Signs, where he now appears, and after he has relinquish'd them, and got into the superior Order, the Comet will both rise after he is up, and set before him, and consequently be render'd invisible thro' his prevailing Lustre.

Again, the Position of its Orbit, whose descending Part was above the Ecliptic, threw its Ascent below it, wherefore a few Hours wou'd determine the Continuance of it above our Horizon, which, as we have before hinted, wou'd happen in Day time, and so not to be discover'd.

But in order to obtain the true Deflection of this Comet's Path, from the Plane of the Ecliptic, the Angle of its Way must be gather'd from Observations, and the Position of its Orbit assign'd, then forming a similar Orbit of Pastboard, let it be rais'd in the Scheme Analogous to that Deflection, at the high end, and depress'd beneath the Sun at the other, and let it be fix'd in the same Position as determin'd in the Heavens: By this Method you shall have the Comet's real Orbit adjusted to the Ecliptic, and the perpendicular Height of its Passage over the Earth's Way acquir'd to sufficient accuracy. From this manner of regulating the two Orbits, you will readily see at what time of the Year we shou'd have been most liable to suffer from its Proximity.

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Those

Those who prefer a Computation to this Method of Procedure, may follow Dr. *Halley's* Rules; or having three Observations from the Earth, Sir *Isaac Newton* has shew'd by what Means the Curve and Position of the Comet may be determin'd in the 30th Problem of his *Universal Arithmetic*.

There is one remarkable Phænomenon which sometimes, tho' very seldom, accompanies the Passage of Comets in their Orbits, and that is what may be call'd Cometary Eclipses; for when a Comet comes in the Syzighial Line of the Sun and the Earth, it must very much abate the Solar Light, tho' its visual Diameter may not equal it: But if it shou'd equal or exceed it, (and such have made their Appearance) if their Course be not exceedingly Vapid, the Sun will be darken'd thro' a much greater extent of Earth, for a much longer Duration, and attended with a more remarkable Obscurity, than any Circumstances of a Solar Eclipse ever can be; such probably might be the *Egyptian* Darknes in the Jewish History, that of *Jupiter* and *Alcmena* in the *Grecian*, and of *Augustus* in the *Roman*; besides others unrecorded in the Annals of History: If any such Accident happen from this, we may expect it about the twentieth of *February*; for the Uncertainty of their Periods, the long Intervals of Return, their

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Numbers undecided, the Eccentricity of their Orbits, and other Anomalies, have admitted of no certain Tables of Computation as yet, by which their Nodes may be positively assign'd, or their Conjunctions truly obtain'd; two principal and material Determinations, before any Calculus can be promoted in either Solar, Lunar, Planetary, or Cometary Eclipses; I mean with regard to all of them Severals: I know are suppos'd to be adjusted.

We have now accounted for the Irregularities of the Comet's apparent Course, as seen from the Earth: Let us remove to the Sun, and contemplate a little the Form of its Procession from a Globe residing in the lower Focus of its Orb. This may be readily accomplish'd, by a repetition of the Method practis'd in assigning the Comet's visible Journey from the Earth: For Example, Stretch a Thread from the radiated Circle, denoting the Sun in the Center, and continue it thro' every tenth Day of the Comet's Position in its proper Orb, as far as the Ecliptic, marking the Intervals, which will truly exhibit the Comet's apparent Course, as beheld from the Sun: This will seem to be very slow at its first coming in, and increase daily as it advances; and betwixt the twentieth and twenty fourth of *February* will be judg'd to have subtended an Angle of half the Firmament: But the vast Disparity of this apparent Motion, arises not from Contrarieties in the

Sun, but from the Distance of the Comet in its first detection, compar'd with its Proximity in the Peri-helion, because from the Sun there is no visible Confusion of Motions, no Retrogressions, Stations, or other Inequalities, but like all other moving Objects, observ'd from a Point of Rest, a slow Procedure when very remote, and a proportionably accelerated one as it approaches; the Planets indeed, whose Orbits are nearly circular, have a greater uniformity in appearance observ'd from the same Place, but the Comets not less regular, all other things consider'd.

We come next to enquire into the true Figure of the Comet's Path, which from its Appearance amongst the Fixt Stars, might be deem'd a Right Line, Circle, or any other Curve; for a Phænomenon which apparently cuts a great Circle of the Sphere, or at least does not seem to move Parallel to it, will be judg'd by the Eye to describe a Great Circle in the Starry Heavens: Hence the Astronomers, conscious of the Fallacy of Vision, determine nothing from Appearances, but ground their Examinations on reasonable Principles; and from such investigate the Laws, Properties, and other Affections of a Comet's Path, whereby they have been enabl'd to assign it with certainty.

By these Means it comes to be discover'd that the true Course of a Comet is not a strait Line; for on such an Hypothesis there wou'd
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be no necessity of the Comet's going constantly to the Sun, or receding from it, as they all positively do; but they might then with unaccountable liberty traverse any Part of the Expansum, and in Regions vastly remote from the Sun, appear, continue and fly off, without ever once looking that way. Indeed such as commenc'd their Tour when the Sun interven'd between the Earth and Comet, wou'd appear to pass the Sun, as if they mov'd actually in an Orbit: But some wou'd certainly make their Stage in opposite Suppositions, and then a visible Approach to the Sun render'd impossible, unless its Line of Passage lay betwixt the Sun and Earth, which cannot be conceded to all. Nor will the Theory of gravitating Matter allow of a simple progressive Impetus to any Body, especially such as wou'd attempt forcing a direct March thro' Planetary Systems, strongly endow'd with attractive Qualities.

Nor can we admit the form of its Orbit to be a Circle, because no Law yet discover'd cou'd then account for the approach of its Peri-helion, and the recess of its other Extremity; nay, it wou'd in great measure contradict the already well-establish'd Principles of the Universe, concerning the foremention'd Gravitation of Matter, which accounting so well for the present regulation of Things, ought certainly to be receiv'd as an inductive Argument, till a better Solution be acquir'd.

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The Parabola, Hyperbola, and all the whole Tribe of infinite Curves, are out of the Question, because they admit of no Return, but recede perpetually from their Axis: Now if Comets revolv'd in Orbits of that Nature, they wou'd eternally proceed thro' interminable Space, and never any more approach the Earth.

By reasoning after this manner, and repeated Observations, the Course of a Comet was discover'd to be Ellyptical, like that of the other Planets, (for Comets are Planets *sui generis*) but differing exceedingly both from them and each other in the Disproportion of the two Diameters of their Orbit; some of them accomplishing their Periods in a Century and less, whilst others take four or five to determine theirs: But whether the other Focus of their Orbit be like the Planetary one, empty; or whether they make not Excursions into other Systems has not yet appear'd?

Dr. Hally in prosecuting the Calculus of a Comet's Way, discover'd that it had more of the Property of a Parabola, than an Ellipsis, which may not seem strange, when the vast Eccentricity of their Orbits is duly consider'd, but was their Course, *ipso facto*, in a Parabola, neither we, nor any Succession of Ages to come wou'd ever see it more.

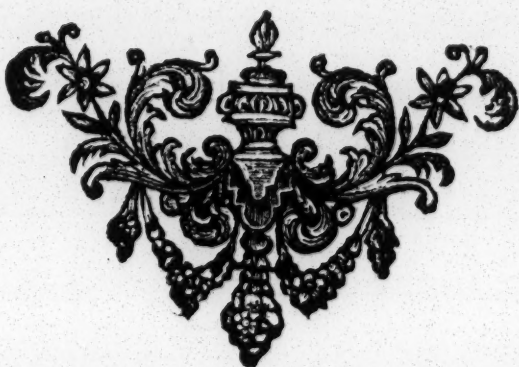
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Having explain'd the Path of the Comets, we will now consider their Consequences, which from a due Contemplation of the Theory of Attraction, will appear of no small Moment, and are therefore greatly to be fear'd in their Approaches. We are all satisfy'd that the Proximity of the Moon is the principal Cause of the Tides; now had this Comet advanc'd within the Moon's Orb, as near as to that of her distance for Sixty thousand Miles from the Earth, its apparent Diameter had fourteen times exceeded the Lunar, and its Quantity of Matter in the Ratio of the Cube of 14 to 1, or as 2744 to Unity; let us suppose that the Moon's Attraction raises the Tide only three perpendicular Yards, seeing that Power depends on the Quantity of Matter in the attracting Bodies (and the Comet is certainly a Body of as great Solidity as the Moon, as shall be afterwards evinc'd) its Attraction in the former Situation had rais'd the Tides 8232 Yards, or above four perpendicular Miles, a height not only exceeding the *British* Mountains, but that of all others in the habitable Globe, and of Consequence had involv'd us in a second general Deluge, exclusive of other Damages.

Again, If the Comet be a Body on Fire, as shall be examin'd in the Sequel, and had its Course been within some few thousand Miles of us, the two Bodies had run together

ther with an impetuous Collision, the Earth had been presently consum'd to Ashes, the Power of its Attraction destroy'd, it had blended in one Orbicular Mass with the Comet, and been hurry'd along with its surprising Rapidity into the Regions of the Sun, from thence making Excursions into the Immenfity of the Universe, hitherto inexplor'd by us, where it wou'd have persever'd in its new acquir'd Revolution, till the Consummation of both, whenever that Decision had happen'd.

Such may one Day be the Fate of this mighty Frame, where Monarchs display their Unbounded Ambition, on whose Oceans the Commercial Interest of busy Life is anxiously carry'd on, whose Plains exhibit the dreadful Apparatus of War, and where powerful Kingdoms stoop to their approaching Destiny.





The History of COMETS from the earliest Account of those kind of Planets, to the present time of their intentional End, and the Sentiments of the Antient and Modern Philosophers on them. With some Remarks on the Nature and Design of Saturn's Ring.

IN pursuing my Discourse with relation to the History of Comets, I shall consider them thro' the *Egyptian*, *Chaldean*, and *Grecian* Periods, as the primary Stages of Antiquity; then examine the *Arabian* Doctrine for the intermediate Ages; and descend to the Days of the last two Centuries for the modern Opinions.

What were the real Sentiments of the Antient *Egyptians*, with regard to Comets, is at this Distance of Time meerly conjectural, the far greatest Part of that valuable Treasure of early Learning having long since perish'd, even to a Consummation; for not a single *Greek* Writer, that I can at present recollect, has transmitted to us the least Abstract of the Opinion of that eminent People on the Cometary System. But *Pythagoras*, who had his Education in the *Egyptian* Schools, and from thence brought home the true Knowledge of the Universe, affords us an ample Field of Conjecture,

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from what he taught, to guess at their Hypothesis of Comets, as I shall presently proceed to shew.

The *Chaldeans* come next in order to the *Egyptians*, tho' whether in point of Priority is much controverted. *Tatius* says, that the *Egyptians* were the first Astronomers, tho' the *Chaldeans* wou'd divest them of that Honour, by vainly ascribing it to *Belus*. *Plato* likewise affirms, that the *Egyptians* and *Syrians* anticipated the *Greek* Astronomy. And *Lucian*, that the *Ethiopians* (he means *Egyptians* surely) first discover'd the Heavenly Motions, with the Lunary Periods and her borrow'd Light. And *Diodorus* more pertinently, that *Belus*, a Son of *Neptune* and *Lybia*, brought a Colony of *Egyptian* Astronomers from their Native Country to *Babylon*, instituting the Ritual Office, and appointing Observations to be made of the Stars, suitable to what they had executed in *Egypt*. On the contrary, *Simplicius* relates, that *Callisthenes*, by virtue of an Order from *Alexander*, carried from *Babylon* the Observations of 1903 Years, which brings us to two Years before *Nimrod's* Death. *Epigenes* again says, they had only engrav'd their Remarks on the Heavenly Motions for a Space of 720 Years. These different Accounts may be easily reconcil'd, by considering, that Astronomy might have begun to flourish in both these Nations very near the same time. In the

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East under *Nimrod*, and in *Egypt* under *Mizraim*, their first Kings, (for there was not above fifteen Years interven'd betwixt the Beginning of the *Babylonian* and *Egyptian* Monarchies under these two Princes, and each of them reign'd a Century and a half at least) there subsisted an equal Necessity of studying Astronomy, for the public Safety, to adjust the true Length of the Solar Year, to regulate the important Seasons of Seed-time and Harvest, from an Inattention to which proceeded the Calamities of frequent Famine, so peculiar to the first Ages: Both of them enjoy'd the Happiness of a temperate Climate, extended and fruitful Plains, an eternal Sunshine and unclouded Sky, essential Motives to excite Attention, and prosecute their Studies with the utmost Application. But then there was this material Difference betwixt the Observations of these two Nations, the *Egyptians* were but little interrupted with Military Avocations, at least not thro' the whole Extent of their Empire; for when the Lower *Egypt* was in Subjection to the Pastor Kings, *Thebes* and *Memphis* continu'd under their own, as appears evident from *Eratosthenes's* Catalogue. On the contrary, the *Babylonians* were in continual Distraction, either on account of their own ambitious Views, of Excursions from *Egypt*, under *Sesostris*, &c. or a long Series of intestine Trouble, and a *Median* Government.

So that tho' their Observations might be a high Date in *Alexander's* Time, they were without doubt broken into Chasms, and discontinued for several intermediate and successive Years, at particular Changes in the Public Affairs, by attending to which the Difference of Account betwixt *Epigenes* and *Simplicius* in his Book *De Cælo*, may be adjusted and reconcil'd, one dating from their Original, without ever adverting to the Interruptions, and the other ingenuously recording what he found on Examination to be Matter of Fact, with regard to the Number of Years actually employ'd in those Studies by the *Babylonians*.

The preceding Account of *Diodorus Siculus*, in relation to *Belus's* bringing an *Egyptian* Colony of Astronomers with him to settle in *Babylon*, very much contributes to support my Conjecture. This *Belus* was, without doubt, *Nabonassar*: Now what occasion had that famous Prince to fetch Astronomers from *Egypt* to *Chaldea*, had there been any previous to them at *Babylon* in his Time?

The Reason of this Historical Digression was principally to see, whether we cou'd with any Certainty discover the real Sentiments of the *Egyptians*, with regard to Comets, by examining the Ancient Records relating thereto. Now *Apollonius*, the *Carian*, positively asserts, that the *Chaldeans* knew the Courses of Comets, and that they were Planets, or wandring Stars
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of a peculiar kind ; and the same Opinion he himself embrac'd, but said he knew not their Course, save that they mounted high into the Heavens, and were only visible in passing the inferior Part of their Orbit. And seeing such were the Sentiments of the *Chaldeans* with regard to Comets, and that the *Egyptian* Astronomers had settl'd in *Babylon* long before *Apollonius* wrote, it follows, that either the *Chaldeans* taught that Doctrine to *Egypt*, or were indebted to the People of that Nation for it. Now *Babylon* seems to have had no Observers of its own, when *Nabonassar* established his Colony there, as I before hinted, and consequently that Hypothesis was *Egyptian*; which shall be more explicitly consider'd in reviewing what was the Opinion of the *Greeks* concerning those Bodies.

Egypt having for many Ages carry'd the Palm in Mathematical Sciences, the *Greeks*, a vigilant and inquisitive People, resorted thither to improve their active Genius, as to the fountain of Knowledge, and came home enrich'd with many valuable Acquisitions, both in the Moral and Mathematical Character. Of these was the great *Thales*, and the greater *Pythagoras*, who taught the Undying Mind in the first, and the true System of the Universe in the last : He had spent Seven Years in *Egypt*, and either thro' Inability to reform the deprav'd Morals of his Countrymen, or a Dislike to the Constitutional Rubric of their Laws, he remov'd

mov'd into *Italy*, and taught that celebrated School, to which Western *Europe* was indebted for the Production of many Great Men. Now *Aristotle*, *Seneca* and *Plutarch* testify, that he, and after him the whole *Italian* Line of Philosophers, maintain'd that a Comet was a wandering Star or Planet of a peculiar kind, which wou'd re-appear after a long Interval of Time. This is almost an incontestable Proof, that the *Pythagorean* Doctrine of Comets was originally *Egyptian*, and sufficiently corroborates what I have all along been endeavouring to explain, with regard to their Sentiments of such Phænomena.

I shall range the other Classes of *Greek* Philosophers under the *Eleatic* and *Ionic* Schools, for the sake of Dispatch: The first were all Atheists under various Denominations, asserting the Eternity of Matter, and the Doctrines of absolute Fatality in their Morals, with the most wretched System of Astronomy in their Sciences, that ever a bewitch'd Sect of Mortals cou'd devise; for they maintain'd that not only Comets, but Planets, Sun, Moon and Stars, were Meteors kindl'd every Morning, by I know not what Plastic Energy, and extinguish'd at Night, by the noxious Damps of the Earth; that they were no bigger than they appear'd to be, with a thousand Foolerics too ridiculous to mention; yet even amongst them, *Democritus*, one of the most subtle of all the Ancients, according to *Seneca*,
held

held, that there were many more perishable Worlds besides this; that Comets were the σύμπαση τῶν Πλανητῶν ἀσέγων, by which I apprehend he meant the Co-appearance of fellow Planets unknown, with such as we are already acquainted with. I was pleas'd to find my Translation warranted from *Hendric's Greek Lexicon*, who interprets σύμπασις, *multarum Stellarum unus emerfus & conspectus, seu Co-apparentia*. See *Aristotle* in his Book of *Meteors*. But *Democritus*, tho' of the *Eleatic Line*, was a better Astronomer than the *Epicureans*, and rejected their Trumpery in Celestial Enquiries.

The Philosophers of the *Ionic Branch*, minded little but *Phyfic*, till the Days of *Socrates*; but that excellent Moralist undertook a Reformation, and founded a School, which subdivided into many Sects, particularly the old *Academic*, call'd also the *Platonic*, the *Peripatetic*, the *Stoic*, the Middle and New *Academic*. Some of these held Comets to be Planets *sui Generis*; but others, and especially the whole School of *Peripatetics*, suppos'd them Meteors generated in the Regions of Air, and expiring with their exhausted *Pabulum*: And this they rather did out of a superstitious Adoration paid to a suppos'd incorruptible Firmament, for they vainly imagin'd the Extinction of Comets wou'd argue a perishable and flitting one, than any Conviction from the Principles of their own Philosophy.

Homer

Homer, the most ancient of the *Greek* Poets, and prior to the Erection of any Philosophic Schools in *Greece*, at least of those before-mention'd, has compar'd *Hector*, in embattling his Troops, to a Comet, or pernicious Star shining thro' the Intervals of Clouds, and by turns obscuring itself; at least his two best Interpreters, *Virgil* and *Mr. Pope*, have each of them understood ἑλὶξ ἀστὴρ, in that Sense, the former adapting the Simile in his tenth *Aeneid*, transferr'd it to his own Hero: You may see the Original us'd by way of Motto in the Title Page of this little Treatise.

From a due Examination of the various Phases of Comets, and their Appellations deriv'd therefrom, arises an uncontestible Evidence, that either the *Greeks* had observ'd a Multitude of those Planets themselves, or else had adapted them into their own Canons, from *Egyptian* or *Caldean* Tables, under *Greek* Phraseology, which makes the Loss of these ancient Treasures inestimable, because irrecoverable. We find mention made of the ξιπίαι, or Sword-like Comet; δισκας, such as resembl'd Quoits; πωγωνίας, bearded ones; ακοντίας, those of the Jav'lin Form; πιδίτες, the Tun-kind; κέραςτιας, when Horn'd; ἵππειαι, such as had the Appearance of a Mane; and again, from their Colour, ἀργυροκόμης, or Silver-hair'd, and in general κόμητις, hair'd.

Most of the Antients embracing *Chaldean* Notions of the particular Life of Stars, gave them

them the Keys of *Destiny*, and made them the sov'reign Dispensers of Fate to subordinate Ranks of Beings. And when long Observations of calamitous Disasters, by the singular Positions and Aspects of the Planets, and the rising and setting of Fixt Stars, had in some Measure confirm'd their Hypothesis, they began to reduce their Registers into Form, and compose a distinct Science; then reasoning from Generals to Particulars, they pretended to know and calculate the Destiny of Nations, and the Fates of the Individuals that compos'd them. This Doctrine, thro' a strange Propensity in Mankind to pry into Futurity, took at first with the Vulgar; and the Poison by degrees infected even the Schools of Philosophy: So that some Stars, as that in *Medusa's-head*, and the like, have obtain'd deadly Properties from these Judicialists, whilst others have been cry'd up for Benevolent Influences, and a third Sort for a promiscuous Nature. No wonder then that Comets, from their unusual and terrible Appearances, were look'd upon as Portentous Omens, and the Nations, where these Vagaries were entertain'd, frighten'd into Panics at the approaching Sword, as some of their Historians have call'd that Class of Planets.

But the true Knowledge of one Intelligent Life in the Universe, that animates All, with the Doctrines of a sounder Philosophy, have of late almost entirely exploded such ridiculous Pretensions, except to those who get

24 *A Treatise of COMETS.*

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But the true Knowledge of one Intelligent Life in the Universe, that animates All, with the Doctrines of a sounder Philosophy, have of late almost entirely exploded such ridiculous Pretensions, except to those who get

a Living from the detestable Practice of Imposture.

The *Romans* study'd Policy and War more than Learning; yet there were some Sparks left of the Genius of the *Tarentine* and *Crotonian* Schools, which flash'd out now and then like Lightning in a dark Night, remarkable for its preceding and subsequent Gloom: Of these was *Seneca*, who affirm'd that Comets were Planetary Stars of undiscover'd Orbits, but Prophecy'd that succeeding Ages wou'd be able to investigate their Paths, and assign their Periods; which is now in some Measure fulfill'd. After *Rome* became Christian, she proclaim'd open War with all Sciences, as unserviceable, nay, repugnant to a Religion whose Basis was Faith. And the *Saracens* reducing *Egypt*, appropriated their Arts to themselves, and Peopling the *African* Coasts, pass'd into *Spain*, reviving the Sciences, and lighting them up in *Europe* again. Mean time the *Arabians* under *Almamun*, and several Princes of the *East*, particularly *Ulug Beghi*, carry'd Astronomy to no inconsiderable Height, composing the *Chovaresmic* and *Sultan* Tables, forming Catalogues of the Fixt Stars, and observing the *Ασωνικ*, or Ecliptic Angle: But from their Propensity to Astrology, I conjecture that they held strange and inconsistent Opinions, with regard to Comets; so I proceed to review the Modern Hypothesis.

After

After *Copernicus* (a Native of *Poland*) had re-establish'd the antient and true System of the Universe, he embrac'd *Pythagoras's* Sentiments of Comets, that they were Planets of a peculiar Orb: And afterwards Astronomers began to observe and watch their Courses, compute their Nodes, &c. in order to adjust their Theory. And the Great Dr. *Halley* proceeded so far therein, as to collect a Series of 24 Comets, whose Peri-helions, Ecliptic Inclinations, and Nodes he accommodated to a Calculus, and publish'd them in the *Philosophical Transactions*, tho' he suspects two or three of them to be a return of the same. The earliest in his Catalogue bears the Date of 1337 in *Raymund Lully's* Time, its Peri-helion Distance from the Sun 33 Million of Miles, the Aphelion Distance unknown, ascending Node in π 24° , $21'$, the Ecliptic Inclination 32° , $11'$, its Motion retrograde, like the late Comet's. We have no farther Accounts of any in this Century; and the next presents us but with one, observ'd by *Regiomontanus*, which mov'd 40° in a Day, in the Year 1472. The succeeding Century produc'd many eminent Astronomers, emerging from the long Night of Ignorance, who have transmitted to us their Accounts of eight Comets. And we have no fewer than fourteen observ'd betwixt 1607 and 1698. See the *Astron. Philolaica*, and Dr. *Halley's Register*.

From what has been said in the preceding Paragraph it will be evident, that Comets are

far the most numerous Collection of Bodies in the Solar System; that probably not one third of them are yet known; that Several which may have enter'd within the Planetary Regions in Summer Months, have gone off again undiscover'd, whilst others might have mov'd in Orbits so apparently near the Sun, that they could not be seen, unless very accidentally when traversing the inferior Parts of their Orbits at the middle of a total Solar Eclipse; that they make Excursions, as if at Random, into all Quarters of the Universe, and move without any regard to an Ecliptic, or more diffus'd Zodiac. This leads me to consider their Nature and intentional End.

The most penetrating of the Antients seem to have had no other Notion of Comets, than as Planets of a peculiar kind; here they rested, without pretending to enquire, why they revolv'd in Orbits so different from the Planets; why they appear'd to be Bodies of Fire; in what manner they were at first kindled, and by what Means continu'd; with other Phenomena relative to them. They cou'd certainly never imagine them inhabited, whatever Opinion they entertain'd of the Planets. *Seneca*, who discourses largely on them, never hints at their Design, notwithstanding he held the Stoical *Ecpyrosis* of the Universe; *Sidera* (says that Philosopher) *Sideribus incurrent, & omni flagrante Materia, uno Igne, quicquid nunc ex disposito lucet, ardebit.* "The Stars shall one
" Day

“ Day rush together, and this well-order’d and
 “ magnificent Frame of Things perish in one
 “ general Conflagration.” We must see what the
 Great Sir *Isaac* says, since we cannot deter-
 mine the antient Opinion; for you see, that
 tho’ they maintain’d the World wou’d be de-
 stroy’d by Fire, they had no Notion of its be-
 ing effected by Comets, unless we allow, that,
 by *Sidera*, *Seneca* means those Bodies, and by
Sidera Sideribus incurrent, Comets either rush-
 ing together amongst themselves, or with the
 Planets. To return to Sir *Isaac*’s Opinion in
 his *Optics*; “ ’Tis, says he unbecoming a Phi-
 “ losopher to devise after what manner the U-
 “ niverse might have been form’d out of the
 “ Chaos by the meer Laws of Nature, altho’
 “ when it was once form’d, it might have pre-
 “ serv’d its Course for many Ages by those
 “ Laws; for whilst the Comets are mov’d in
 “ Orbits so vastly eccentrical to and from all
 “ Parts of Heaven, it can by no means be at-
 “ tributed to a blind Fatality, that all the Pla-
 “ nets move one way, in concentrical Or-
 “ bits, except a few Irregularities scarce worth
 “ Notice, and which may have arisen from the
 “ mutual Action of Comets and Planets upon
 “ one another; and which, probably may in-
 “ crease in length of Time, till at length this
 “ Frame of Nature comes to want a mending
 “ Hand.” He elsewhere thinks that the Chan-
 ges which appear in a Comet, are only in the
 thick Fumes and Clouds of its burning At-
 mosphere,

mosphere, and not in the Nucleus itself, that the Comet of 1680 exceeded the Heat of red-hot Iron 2000 times, &c.

Mr. *Whiston*, to whose Labours the Learned World is not a little indebted, thinks that all the Changes this Earth of ours has undergone, or may yet undergo, was and will be effected by their Means. From the Comet's Head and its condens'd Atmosphere this Globe originally sprang, and by one of that Order will be again destroy'd; that Comets may, probably, be huge Chaos's of unform'd Matter, preparing for the Formation of New Worlds, whose long elliptical Paths may be easily converted into circular ones. In a third Supposition he judges it not unlikely, that they may be appropriated for the Punishment of Impenitents after Death. There are none of these Reasons that appear to me sufficient to account for such a Variety of Phænomena: A few Comets wou'd have been sufficient for a Hell to the whole Planetary System; and tho' there seems to be many, nay, innumerable Systems besides this, no satisfactory Reason can be urg'd, why they are without their own Comets, and ours so plentifully stock'd with them, as to form Places of Punishment for the Universe. Nor has their Excursion into all Regions and Quarters of intersidereal Space, without any regard to an Ecliptic, been at all accounted for, on any or all these Hypotheses taken together, tho' they may serve as secondary Ends to a

more

more general and comprehensive One; which I proceed to consider.

'Tis evident that Air is a fluid permanently Elastic, whether of the volatiliz'd Effluvia from Bodies, or a Medium of itself not material; the more dense and heterogenial Parts encompass the Earth and Planets, forming what is commonly call'd their Atmospheres, whilst the exceeding rare and homogenial Fluid, in the Ratio of its Volatility expands thro' the whole Interstellar Regions of the Universe, and composes its ætherial Fluid, almost entirely incapable of Resistance. Now it has been observ'd by some eminent Philosophers, that if it was not for the Fire with which Air is impregnated, and the Action of the Solar Beams, it wou'd probably freeze into a solid Mass. In the Regions therefore of intermediate Space beyond *Saturn*, where the Action of the Sun has no Force, but Cold eternally Reigns, as on its native Throne, what Provision cou'd hinder the Æther from a general Coalition of these fine Effluvia into a permanent Stability of its Parts, equal to those immense Bodies of Fire, that are perpetually traversing all Quarters of it, and extending their flaming Atmospheres to several Thousands, nay, Millions of Miles around them. By their Means the Communication with other Systems is constantly kept open, in Regions where no Planet cou'd subsist with its Natives, for want of Heat and Light: And the farther they launch
out

out into the interminable Void, the more eccentric are their Orbits, and by consequence the nearer will they advance to the Sun in passing their Peri-helions, and imbibe the Heat with far greater Degrees of Intensity, to enable them to preserve it thro' all the Stages of their long Journey, till they renew it afresh in the Solar Beams, and return to their proper Charge. This gives a substantial Reason for their disregarding the Ecliptic, and flying off *quaquaversum*, into every district of Space, at the same time that it gives a plausible Conjecture (if it amounts to no more) for their being Bodies on Fire, and most intensely Heated. But tho' this may be the chief intentional End of Comets, it excludes not subservient ones: Many necessary Expedients may be accomplish'd by one well-order'd End, conducive to the general Welfare of the Universe, from the All-wise Foresight of its Intelligent Life.

Such a Provision may farther appear requisite, if it be consider'd, that was the ætherial Fluid to Freeze, the Calamity wou'd gradually encrease, and might in time prove of destructive Consequence to the two largest and remotest Planets of our System, which enjoy so small a Share of the Solar Heat, that it might Freeze their Atmospheres, and incrust them in Firmaments of solid Ice. Now the numerous Collection of Comets prohibit such Accidents, by perpetually traversing the Interstellar Regions, and never entering the Pla-

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Planetary ones, but for a Renewal of their Fire.

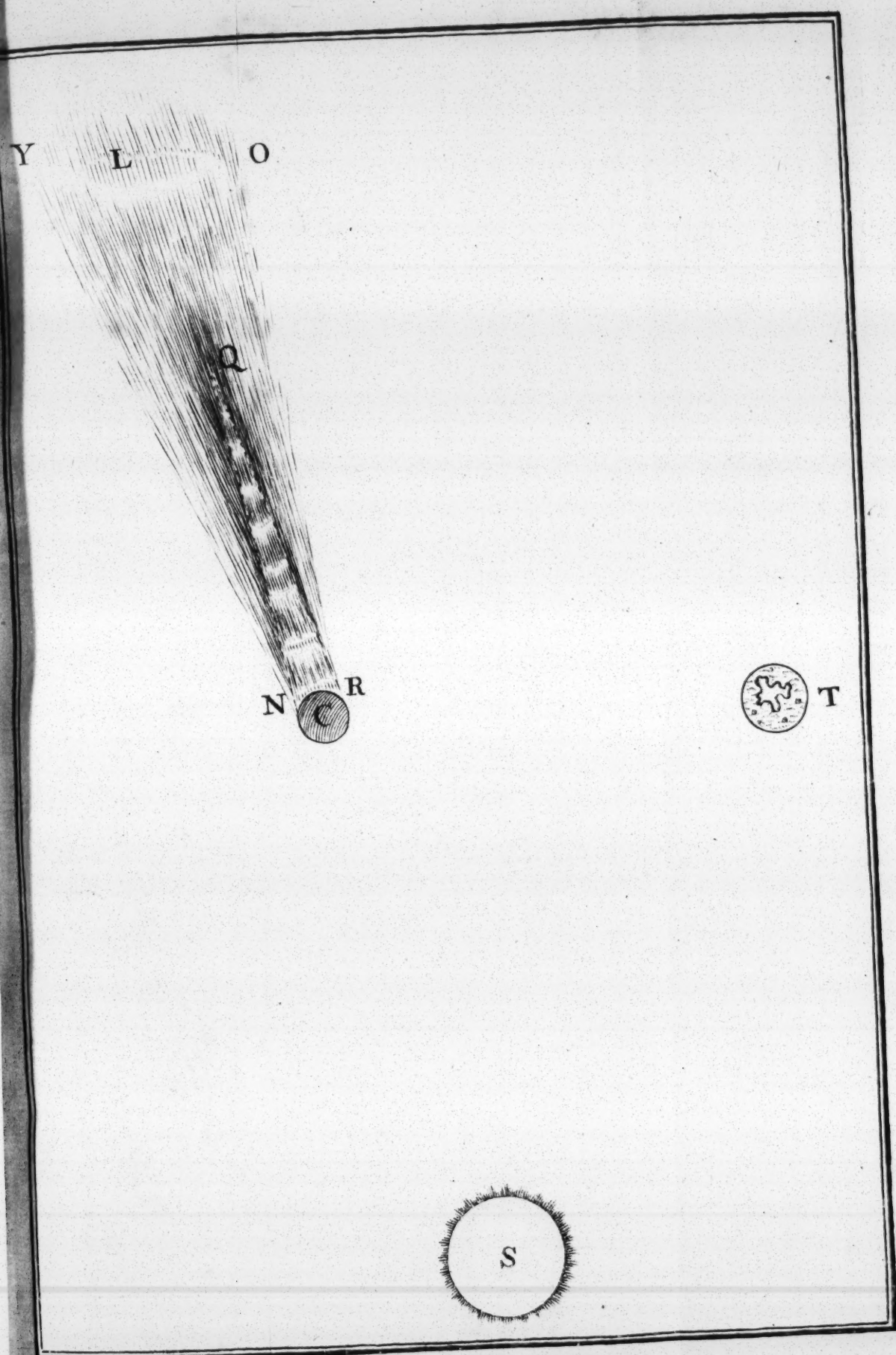
It will be a Means to strengthen my Hypothesis, if we reflect on the Nature and Design of *Saturn's Ring*, which appears not unlikely to be a sort of diaphanous Medium, contriv'd for the Collection of the Solar Rays, to warm, in some measure, that extremely cold Climate, whose Æquatorial Regions surpass our Polar ones. Round no other Planet can be discover'd any thing of so wonderful a Kind. Nature, which makes nothing in vain, has doubtless design'd and appropriated it for some wise End, and most probably for this here specify'd. The Obliquity of this Ring, at different Periods, in the Revolution of *Saturn*, to his Ecliptic, in a great measure supports my Conjecture; for, when elevated over the Northern Zones, those Climates may have their Summer, and in the opposite Position their Winter. To conclude this Head, Since this Hypothesis of Comets solves every known Phænomenon of their Appearances, such as their being Bodies on Fire, the Eccentricity of their Orbits, their Disregard of our and all Planetary Ecliptics, their Numbers, &c. we ought to adopt it as an inductive Argument to be parted with when a better can be discover'd.



The Distance, Velocity, Size, Solidity, and other Properties of Comets considered; and the wonderful Phænomena of their Tails, and Atmospheres accounted for, in a new, and rational manner.

WE come now to enquire into the Properties of Comets, such I mean as are co-essential to those Bodies, so that none have appear'd without them; and, for the sake of Method and Dispatch, I shall consider their Distance, Size, Velocity and Solidity together.

The great Comet of 1680 came to its Perihelion *Decem.* the 8th at Noon, and its Distance was then only 496000 Miles from the Sun's Center; so that he wou'd appear from the Comet to cover almost half the Firmament of Heaven, and the Comet wou'd sustain a Heat superior to 2000 times that of Red-hot Iron: Its Tail was 80 Millions of Miles long, and its Orbit so vastly eccentric, that the Aphelion Heat to the Greatest, was as 400 Millions to 1; and its Revolution computed at a Period of 575 Years. In the Extremity of its Orbit it appear'd, from Calculation, to be Twelve Thousand Million of Miles distant from the Sun; but tho' this had the greatest Eccentricity of



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of any yet discover'd, we cannot conceive but that Several may exceed it, and far too.

The Orbit of the late Comet, tho' vastly Eccentric, fell considerably short of that just mention'd, yet it pretty near equall'd that in 1665 of the same Century, for it exceeded the apparent Diameter of *Venus* in Apogee and approach'd the Sun's Center within Ten millions of Miles probably. Computing therefore on the Ratio of visible Diameters, we may reasonably judge, that the Body of the Comet was about the Size of our Earth, and its Tail about Six Millions of Miles long, (allowing that the Comet's Diameter subtended 80", and in Measure 7000 Miles) for the Tail stretch'd to 20° at least. About the 23d of *December* it might be entring the Planetary Regions; supposing then that *Venus* in Perigeo appears under an Angle of 84", and is then Twenty Millions distant, her apparent Diameter, if remov'd to *Saturn*, wou'd not much exceed two Seconds, and such the Comet seem'd to be at the time specify'd. In 50 Days Time then it had mov'd over a Space of 670 Million, or about 13 Million a Day; but that Motion wou'd not be equable, being accelerated in its Descent to an incredible Velocity, by the Power of the Solar Attraction; so that in the inferior Part of its Orbit it much exceeded Six Hundred Thousand Miles an Hour, or Ten Thousand Miles a Minute, a Rapidity inconceivably superior even to Lightning itself. In its nearest

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approach to the Earth, it seems to have been about Sixty Million of Miles distant; but the Period of its Return, and length of its Aphelion I have not yet determin'd.

The Comets must be hard, compact, and surprisingly durable Bodies, otherwise the intense Heat of all their Parts, which are in perpetual Fusion, thro' a fixt and permanent Fire wou'd dissipate them into Fumes and Vapours in a few Ages; but the perseverance of the Matter in an endless Fire, argues them to be of a solid and almost incorruptible Nature for Comets shine with more Vivacity, when they reflect the Sun's Light in his Neighbourhood; yet that in a great measure is owing to their Nearness and Increase of Heat from the Solar Rays; for notwithstanding their Solidity endues them with the Property of Reflexion they acquire such a permanent Flame from the Fire of the Sun, as will require above Thousand Years to cool it. Now the longest Period of any yet discover'd, exceeds not 57 Years, and not a few return in a quarter of that Time, and Several in much less; hence they will continue thro' all Stages of their Revolution with inconceivable Heat, and emit copious Flames from their burning Atmospheres, to several Thousand Miles round them in all the extent of their Progression, till the abating Ferment be again renew'd in the Solar Beams.

Comets have therefore a peculiar Light of their own, which might be originally propagated to them from the Sun, and now regulated and continu'd by him, till their Consummation.

If it be alledg'd, that some of the Comets, whose Peri-helion lies without the Earth's Orbit, (such as that of 1585 appears to have been) cannot have their Heat renew'd at such a Distance from the Sun, sufficient for the Purposes I seem to require from them, I answer, That all of them seem to be Bodies of Fire; which way they came to be so, is not the Province of a Philosopher to determine; that they preserve their Heat is evident, before they enter the Planetary System in their Descent to the Sun, when coming from the Regions of eternal Cold; they shine and emit a Tail, even there where they cannot be suppos'd to be set on Fire by the Solar Beams; and how a large Body may for Ages conserve its Fire, without supposing a Renewal, may be seen in the Words of one of the greatest Genius's that ever the World produc'd, tho' he determines not how they came by it, resolving it into the wise Contrivance of the First Cause, as an Expedient to answer his Purpose in the Measures of the Universe. "Do not
"great Bodies, says that Author, conserve their
"Heat the longest, their Parts heating one a-
"nother? And may not a great, dense and
"fix'd Body, when heated beyond a certain
"De-

“ Degree, emit Light so copiously, as by the
“ emission and re-action of its Light, and the
“ reflexions and refractions of its Rays, with-
“ in its Pores, to grow still Hotter, receiving
“ continually more additions of Heat from
“ these, than of Refrigeration from any other
“ Causes, till it comes to a certain period of
“ Heat, such as is that of the Sun? And are
“ not the Sun and Fixt Stars great Earths ve-
“ hemently hot, whose Heat is preserv’d by
“ the greatness of the Bodies, and the mutual
“ Action and Re-action between them, and the
“ Light which they emit, and whose Parts are
“ kept from fuming away, not only by their
“ Fixity, but also by the vast Weight and
“ Density of their incumbent Atmospheres,
“ very strongly compressing them, and con-
“ densing the Vapours and Exhalations which
“ arise from them ?” *Sir I. Newton’s Optics,*
Lat. Ed. Q. P. 296.

There appears, however, according to my Hypothesis of Comets, an absolute necessity for the different Eccentricity of their several Orbits, because if they all launch’d out into the same distance of Space from a general Center, their Periods wou’d be comprehended within a globular Figure, whose Center wou’d be the Sun ; and the Cometary Bodies of other Systems being of the same Form, every three of them wou’d have a large quantity of Space interjacent, into which no Comet cou’d come, and by that means be unserviceable to promote

mote the End allotted them in this Treatise; for this Reason principally, their Orbits have widely varying Degrees of Eccentricity, the largest yet discover'd being about Twelve Thousand Millions of Miles distant from the Sun in the Aphelion; for this Reason they are sent off with their flaming Equipage into all Quarters of Heaven; so that the Cometary Orbits of the neighbouring Systems, have their Eccentricity the least where ours is the greatest: and, *vice versa*. What a regulating Care must therefore the Intelligent Life of this Universe have, that keeps so many Millions of moving Worlds in widely different Orbits, and for widely different Purposes, from a general Coalition of the whole into one immoveable Mass!

If we knew which was the most and least eccentric Orbit belonging to our System, the Distance of the nearest Fixt Stars might be thereby accurately Computed, and wou'd fall much short of that generally assign'd them by Astronomers, if Orbits of a larger Eccentricity be not afterwards discover'd than those we now know; for then those specify'd wou'd not exceed Twenty Thousand Millions of Miles at most, tho' others might exceed ten times that Quantity, and some much more.

The Objection to this Nearness of the brightest Fixt Stars, from the annual Parallax being undiscoverable amongst them, makes but little to the Purpose, if we consider, in the first Place,

Place, that the Attempts to find it were made on some Stars in *Draco's-Head*, which at most exceed not the third Magnitude, and consequently may be many Millions farther off than those of the first. Again, Suppose one of the two bright Stars of that Order, which pretty nearly pass our Zenith, to wit, *Capella* or *Lyra*, were chose for the Purpose, and let us assign them only Twenty Thousand Millions of Miles Distance; in that Situation our Sun wou'd but subtend an Angle of six Seconds in his apparent Diameter, and I cannot believe that Stars of the first Magnitude subtend less, because of the Insufficiency of Instruments to observe Angles of a Size so exceedingly minute.

Now the Diameter of the annual Orbit (supposing it 140 Millions) is to the Distance of *Lyra*, or 20000 Millions, as 1 to 143, or nearly the same as if I took the Length of a single Chain for a base Line, to measure the Distance of an Object that was almost two Miles remov'd from either End, what sensible Angle the Object wou'd form at itself with the Extremities of so short a Line, those who deal in Trigonometry can easily discover; for by Computation it will not exceed 20' or one third of a Degree, which tho' Instruments can sufficiently observe, I know not whether ever these Stars have been apply'd to for that Design; and if they have, it will argue nothing to the Purpose, until Comets of the most and least eccentric Orbs are positively discover'd.

Comets,

Comets, as Sir *Isaac* has very justly observ'd, may be kept from fuming away by the density of their incumbent Atmospheres, which seem to be in perpetual Agitation, with Clouds of lucid and sulphurous Smoke flying in them and altering their Figure, with the constant Emanations of fresh Flame from the Comet's Body. If Comets had not an Atmosphere endu'd with a peculiar Quality of administering a constant Pabulum to the Flame, they wou'd go out, in their Progress thro' ætherial Regions, for want of a proper Supply; for in all Planetary Bodies, there is a vast expence of Air requisite to support Flame; there must then either be an incumbent Atmosphere around them, of a Property to maintain this Expence, or else a perpetual resort of fresh Æther into the attenuated Regions of Flame, within the extent of the Comet's Fire, and, probably, both these may be the Case; and this rapid Motion of succeeding Æther, may be another Means to preserve it in a fluid State, and prevent its Coalition into an impenetrable Mass, as before explain'd.

Comets, from their various Appellations, have certainly appear'd in sundry Forms, but the most common are the Ensi-form, or Sword-like Comets, which project an immense Tail into the Regions opposite to the Sun, a Phænomenon which deserves a particular Explanation.

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They have been generally understood by Astronomers, to be a Column of emanating Fire, darted with impetuous Rapidity from the Comet's Body, into the forementioned Quarter; but they have, as yet, assign'd no probable Reason, that I know of, for that singular Position of their Tails, regarding unexceptionably always one Quarter; which I proceed to shew.

The most lucid Part of their Tail is of a Conic Shape, but obtuse at the Point; this is envelop'd by a thinner Stream of Light, which diffuses as it extends, till it becomes altogether imperceptible by its Rarity, and this second Stream is brighter towards the Edges of the luminous Cone, and fainter towards its own. Astronomers teach, that all opake Objects project a Shadow similar to themselves, into the Regions opposite to the Sun; which Shadow is of two kinds, one an absolute, and the other a penumbral Shadow; the first terminates in an Apex, because of the Sun's superior Magnitude, blunted at its Extremity, by reason of the Refraction of the Solar Rays in the Comet's Atmosphere, as the same Cause renders our Moon visible in a total Eclipse, tho' the Earth's Shadow exceeds her apparent Diameter. The penumbral Shadow has its Vertex betwixt the Sun and Comet, and therefore is only Imaginary, whilst itself
diffuses

diffuses into indefinite Space, till the Solar Beams break so much in upon it as to destroy it to all appearance. This any Person, but tolerably vers'd in the Astronomical Doctrine of Shadows will easily admit, because it may be demonstrated.

Let now S represent the Sun, T the Earth, and C the Comet, N Q R will exhibit the black Cone of the Comet's Shadow, projected into the Expanse: Now as this Shadow will be constantly turn'd from the Sun, the emitted Stream of lucid Vapour in the Comet's Atmosphere will appear in its Shadow, when it cannot be seen on any other Side, as being absorbed in the superior Rays of the Sun, on all other Quarters. This luminous Stream will be also visible in the penumbral Shadow, but exceedingly faint towards the Edges, on account of Interruptions from the increasing Light of the Sun, as it approaches the termination of Light and Darkness in the penumbral Cone: And for the same Reason it will grow extremely thin towards its upper diffusing Stream, because in those Regions the apparent Diameter of the Sun, which at the Vertex of the absolute Shadow was equal to the Comet's, is there become much superior to it, and consequently the Penumbra strongly illuminated with Solar Beams; so as in its Progress to stifle and entirely sub-

due the emanating Stream of the Comet's Atmosphere, which, on that account, becomes invisible, being so intermix'd with Rays of Light, that it can no longer exhibit its Lucidity. The Reason is therefore evident, why its Tail must always be directed in Opposition to the Sun; for there, and there only, can this penumbral Shadow of the Comet be projected, the Solar Beams enveloping all other Sides, extinguish the Appearance of this flaming Atmosphere every where else; whereas, was it not for the Sun's superior Lustre, the Comet wou'd seem like a bright Nucleus surrounded on every part with an extended Orb of Fire, which now appears only in its Shadow.

By means of this Cone, if its Altitude was determin'd, and the Semi-Angle given, the Diameter of the Comet might be easily computed, (and *vice versa*,) by a Method analogous to that by which Astronomers calculate the Height of the Earth's Shadow from the Angle of the Cone, and its Diameter given: But as I have all along endeavour'd to avoid the Process of Computation, I shall leave it to be persu'd by others, and proceed according to my first Plan.

When the Comet approach'd the Horizon, its Tail appear'd sensibly bent, which was
occa-

occasion'd entirely by the Refraction of the Air, by which the Comet's Body appear'd to be elevated above the Horizon, when it was actually set, and the different Parts of its Tail, according to their Elevation, undergoing different degrees of Refraction, bent it into the form of a Curve, such as it seem'd to be.

Thus have I, in a new and intelligible Method, explain'd the several Circumstances of the late Comet, and the Phænomena of other Comets, as they occur'd: If there appears in it any thing that may be of Service to a farther Illustration of their Theory, I have my End, grounding this Publication on nothing but a Readiness of communicating what I apprehended might be useful to this or a succeeding Age, in order to compleat this Science. Any other Comets, besides the two last I never had the Pleasure of seeing, so am not solicitous about accounting for Phases that I have not beheld, tho' I imagine it wou'd be attended with no great Difficulty, if a little Consideration was employ'd about them; but that I leave to another Time, having fulfill'd the Design of this introductory Tract, agreeable to my first Proposals. There are as few Astronomical Affairs intermix'd with it as in a Subject of this Nature cou'd possibly be avoided,
by

by which 'tis hop'd that I have render'd it more familiarly instructive and entertaining, at the same time that I have adapted it to a far greater Number of Readers.

Feb. 16.

G. S.



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